

Space Weather Technical Forecast

Issued on Tuesday, 07 February 2023 at 13:01 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of M-flares (R1/R2 Radio Blackouts).**Analysis of Space Weather Activity over past 24 hours**

Solar Activity: Low with eight sunspot regions on the disc. Peak flare was a C7.8 from AR3211 in the southeast. This is a small region that is soon to rotate off the disc. The most developmental regions are currently AR3213 Dsi/Beta-gamma and AR3214 Dsi/Beta, both in the northeast, with ongoing growth observed. A large filament is also present across the southwestern hemisphere, however this currently appears stable. No Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: Elevated solar winds are ongoing with Earth having moved into and through the fast wind originating from coronal holes 74 and 75. Observed speeds at L1 increased from 400-450 km/s to around 500-550 km/s, with density around or below average. Total IMF strength, Bt, was Weak to Moderate, with peak value of 11 nT around 07/0000 UTC, and generally ranged between 8-11nT since. The north-south component Bz, was variable, but more generally southward directed ranging -11nT to +8 nT. Phi angle was mainly negative (towards the Sun). Geomagnetic activity was Quiet to Active (Kp 2-4).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 remained at Background levels throughout. The high energy electron flux (greater than 2MeV) measured by GOES-16 was predominantly at Background. The associated 24-hour electron fluence was below the Active level, with the observed fluence at 07/0000UTC being 1.08e6 integrated pfu.

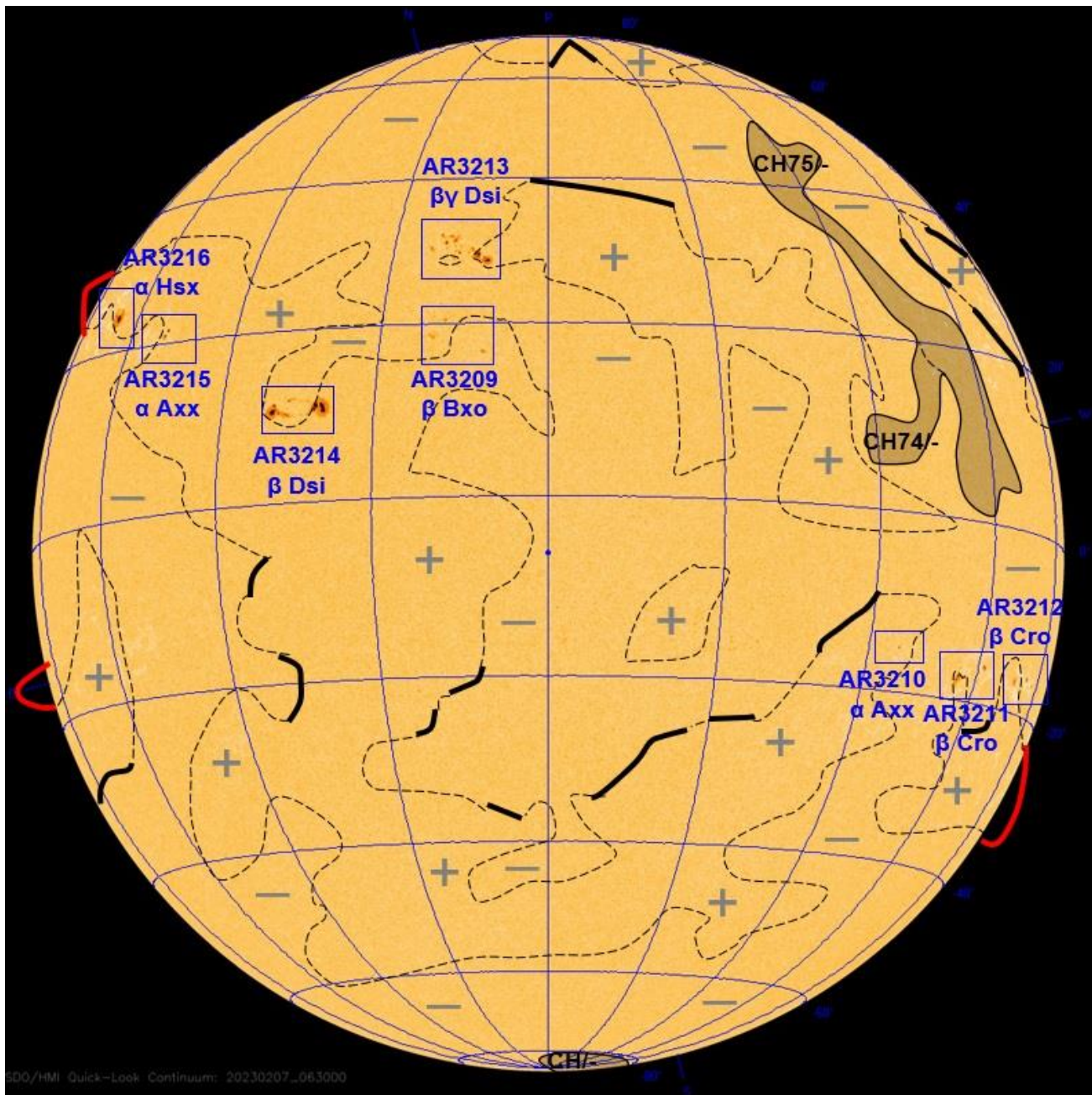
Four-Day Space Weather Forecast Summary

Solar Activity: Low Activity at first, but with a chance of rising to Moderate. This due to the potential for M-flares from the developing sunspots in the northeast disc, and with further regions expected to rotate onto the disc during the period.

Solar Wind / Geomagnetic Activity: CMEs which left the Sun on the 4th and 5th and, while forecast to miss the Earth, give a low chance of glancing interactions through days 1-3 (7th-9th). Otherwise, the ongoing elevated solar winds due to the fast wind enhancement from CH74 and CH75 is forecast to gradually ease, with no other coronal hole sourced enhancements expected. Mainly Quiet to Unsettled geomagnetic activity is expected, however given current fast winds and the low confidence CME outlook, Active intervals are possible, but mainly days 1-2 (7th and 8th).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels. High energy electron flux is expected to rise from mainly Background to occasionally Moderate levels, with a chance of reaching High levels. The associated 24 hour fluence is currently expected to rise in response, but remain below the Active threshold (1e8 integrated pfu).

Figure 1. Solar Analysis Valid 07/0800 UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

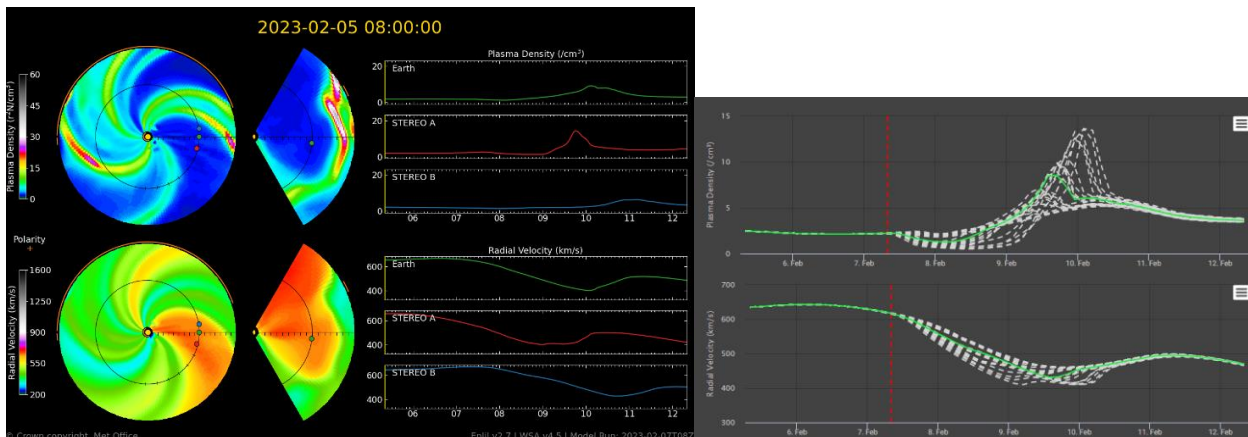
Geomagnetic Storms:

A number of CMEs are expected to miss, but pass close to, Earth over the coming few days. These left the Sun on the 4th and 5th, and given some uncertainty in their analysis, may give some peripheral interactions during days 1-3 (7th-9th). Confidence is reduced further due to enlil currently over estimating the strength of the current fast wind environment. This is due to Earth moving through the fast wind originating from coronal holes 74 and 75. These solar winds are expected to ease through the period, with no further enhancement expected.

Mainly Quiet to Unsettled geomagnetic activity is expected, however given current fast winds and the low confidence CME outlook, Active intervals are possible, but mainly days 1-2 (7th and 8th). There is a very slight chance of G1/Minor Storm intervals throughout.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	10	10	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC Enlil and Ensemble



Radio Blackouts - X-Ray Flares:

Solar activity is currently Low with eight sunspot regions currently on the disc. Activity is forecast to increase through the period, with an increasing chance of M-flares.

The most developmental are AR3213/Beta-gamma and AR3214/Beta, both in the northeast disc. AR2313 is a relatively small region, with only rudimentary penumbra on its trailer spots, but weak spots to the south of the trailer have resulted in a slightly more complicated beta-gamma magnetic configuration. AR3214, while the larger of the two regions, currently has a simpler and more stable east-west bipolar configuration. Growth is ongoing in both of these regions however. The other regions on the disc are smaller and simpler.

Further regions are expected to rotate onto the disc, including ex-AR3190 and ex-AR194 in the southeast, both of which were sources of flare activity on their previous transit. With some notable magnetic looping also evident on SDO aia-171 and STEREO A euvi, this also adds to the risk of flare activity through the period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	2	5	5	5

Figure 3: GOES-16/18 X-ray Flux

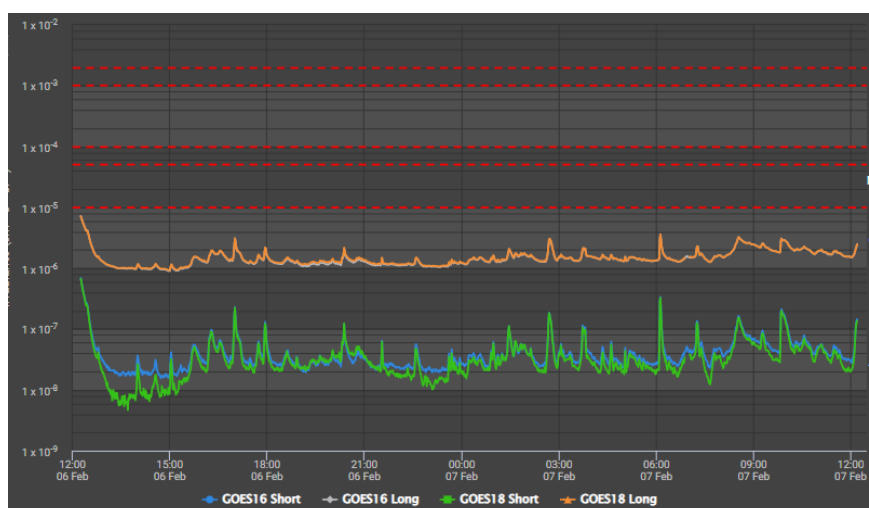


Figure 3b: NE quadrant sunspot (intensitygram left, magnetogram right)

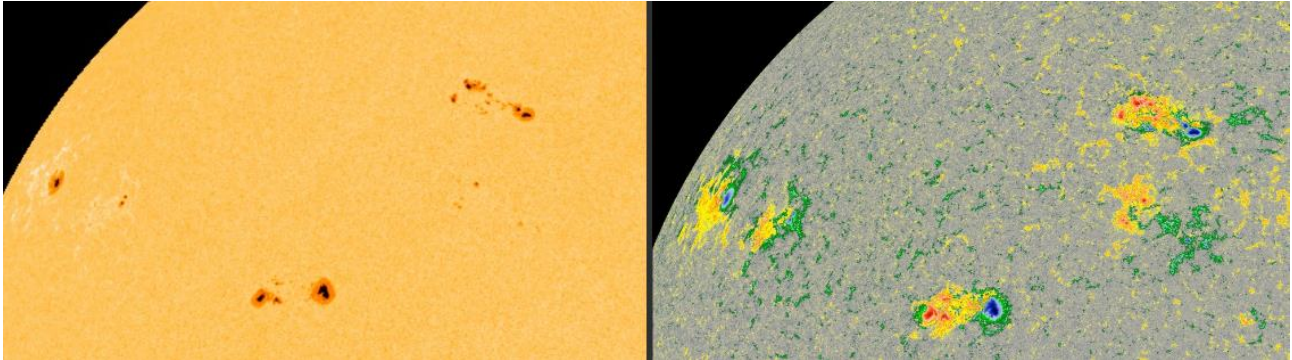
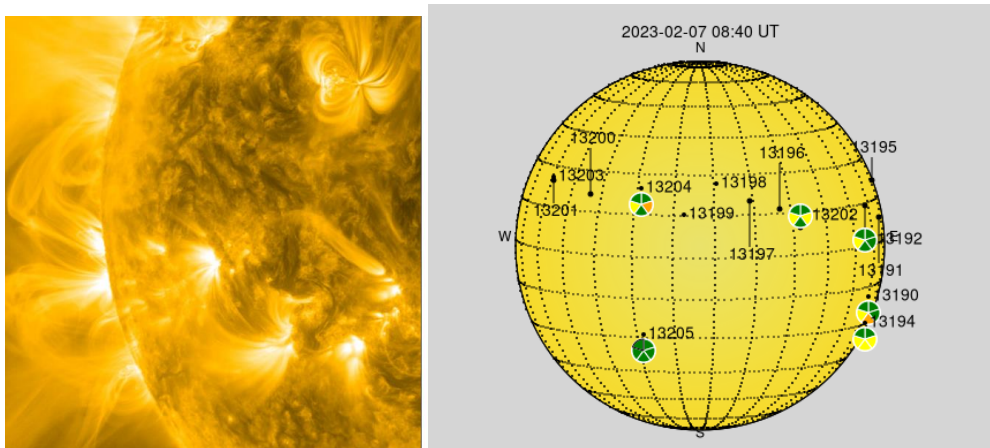


Figure 3c: SDO aia-171 showing clear over the limb magnetic looping on limb (left) and raben.com far-side map right, showing potential returning regions in bottom right which would be the source.



Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux as observed by GOES16 is at background, and is currently expected to remain at this level given the absence of significant flaring and complex western solar hemisphere sunspot groups.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	1	1	1	1
Very Active	$\geq \text{S3}$ *	No	1	1	1	1

* $\text{S3} \geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)

High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux (greater than 2MeV) as observed by GOES16 is currently at background levels, but is likely to rise to Moderate at times during the period, as a consequence of the recent slight enhancement to the geospace environment from the arrival of coronal hole fast winds. This will bring a chance of reaching High during diurnal maximum by the end of day 2 (8th)

The associated 24 hr fluence is likely to rise, but expected to stay below the Active threshold ($1\text{e}8$ integrated pfu). REFM suggests a flatter trend, however this is currently poor guidance, as it likely doesn't yet account for the recent enhancement to solar winds.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	20	20	20
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: GOES -16 Electron flux (top) with Fluence and REFM (bottom)

